Acoustic Tomography With Navy Sonars

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LONG-TERM GOALS

The long-term goal of this contract is to determine if a wide variety of Navy sonars can be used to map the sound speed field by means of acoustical tomography for use in research and surveillance. The Sound Surveillance Systems (SOSUS) have traditionally been used for obtaining acoustical tomography data. The Navy has many more sonars than these, and their use should significantly enhance the accuracy and resolution of tomographic maps.

OBJECTIVES

We will utilize different types of active and passive Navy sonars, and electronically controlled acoustic sources deployed by scientists, to determine if Navy sonars can be used to make tomographic maps using a Kalman filter. In particular, we will utilize data from towed arrays, which should provide a synthetic aperture for increasing the resolution and accuracy of tomographic maps (Spiesberger *et al.*, 1997). We need to determine if the data from towed arrays have sufficient signal-to-noise ratios, and if the acoustic paths can be identified from a model, as has been demonstrated with data collected at SOSUS stations (Spiesberger and Metzger, 1992, Norris *et al.,* 1998). Our objective is to compare tomographic maps from towed arrays with those from only SOSUS stations in order to compare the advantages and disadvantages of using towed arrays.

APPROACH

We will collect pulse like acoustic signals on towed arrays for transmissions over 1000 km. The data will be beamformed, Doppler corrected, and matched filtered if possible. The processed signals will be analyzed to ascertain if they are of sufficient quality to be used to compare with acoustic models of the propagation over the same sections as measured. If the acoustic models can be used to successfully identify the acoustic paths from each transmission, a tomographic inverse will be applied to the differences in travel time between modeled and measured paths. The principal investigator will collaborate with Andrew Jacobson on the tomographic inverse.

WORK COMPLETED

We collected and processed signals from tomographic acoustic sources at distances of 1500 to 3000 km on several towed arrays.

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RESULTS

For an as yet unknown reason, we are surprised to find that forward models based on ray theory are not usually yielding model results that successfully resemble the measurements on towed arrays. The model is currently using historical time and space averages of sound speed based on data compiled by Levitus. It is puzzling to us that the forward modeling appears to be more difficult for the sources and receivers we are currently analyzing than for the sources and SOSUS receivers we successfully analyzed during the last 25 years. The successful modeling at SOSUS stations was also done by tracing rays through historical time and space averages of sound speed. For the few cases where our models resemble the data collected at towed arrays, it appears that the discrepancy in travel time between models and measurements is about 1 s, the same as observed from SOSUS stations (Spiesberger *et al.*,1998).

IMPACT/APPLICATIONS

It appears that more is to be learned about what is required to accurately model sound propagation over long distances than what we learned during the past 25 years from SOSUS stations. It is important to understand how to accurately model the amplitude and travel time of sound over long distances in the ocean.

TRANSITIONS

The results of this research are not yet utilized by the operational Navy.

RELATED PROJECTS

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